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# Advanced adaptive autopilot proves successful on JDAM flight tests

***by Rex Swenson, AFRL/MN Public Affairs***

*EGLIN AIR FORCE BASE, Fla.* — The Air Force Research Laboratory Munitions Directorate's Navigation and Control Branch (AFRL/MNGN) has been working with Guided Systems Technologies (GST) to develop a neural network-based nonlinear adaptive autopilot capability that will reduce the dependence on wind tunnel testing for flight demonstrations, munition configuration upgrades, and pre-planned product improvement developmental programs.

A Phase I Small Business Innovative Research (SBIR) project with GST, a small business associated with Georgia Technology Research Institute (GT), demonstrated the Advanced Adaptive Autopilot (AAA) concept feasibility on the Small Smart Bomb airframe model.

According to Johnny Evers, AAA Program Manager for MNGN, The recent Phase II SBIR project has focused on further development of the AAA concept for the Joint Direct Attack Munition (JDAM) family of weapons.


*An F-16 makes the first guided test vehicle drop, which achieved all its mission objectives and was accomplished from an altitude of 25,000 feet on Eglin's B-70 test range (Courtesy photo)*

With support from Boeing (the JDAM prime contractor and a subcontractor on the Phase II SBIR project) GST and AFRL/MNGN conducted two free-flight test missions to demonstrate the new autopilot technology using updated Anti-Jam Global Positioning System (GPS) Technology Flight Test (AGTFT) MK-84 tail kits.

"The AAA technology allows for the design of a new autopilot based upon only an approximate aerodynamics model. The payoff of this capability is the ability to rapidly prototype modifications to the airframe, or even new airframe variants without the need to go to costly and time consuming high fidelity wind tunnel tests," Evers said.

The benefits are obvious for a continuously evolving weapon system such as JDAM. Members of the JDAM family employ satellite-based GPS for navigation to achieve very high accuracy of delivery to targets in all weather conditions, day or night. Traditional autopilot design for such munitions depends strongly on the availability of wind tunnel data to characterize the munition's aerodynamic forces and movements. "Through on-line learning, the adaptive autopilot is able to compensate in flight for uncertainty in aerodynamic data, and can therefore greatly relieve dependence on wind tunnel data in the autopilot design process," explained Evers.

The AAA replaces JDAM's existing gain-scheduled autopilot software with no other changes to the airframe hardware or software.

The first controlled test vehicle (CTV1) drop was accomplished, and achieved all mission objectives over the Eglin Air Force Base water range in the Gulf of Mexico. The weapon was dropped from an altitude of 35,000 feet and followed a preprogrammed controlled flight profile designed to exercise the autopilot stability and performance. Based on telemetry data obtained during the test, the autopilot performed as intended.

"In fact, the AAA allowed the weapon to achieve controlled flight at negative angles-of-attack; this was a first for the MK-84 JDAM," Evers concluded. **@**